

FM680

User Manual for Virtex-6 XMC card

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Revision History

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August 17	Added image 10 for the JTAG connector location	1.4
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Acronyms and related documents

1.1 Acronyms

ADC	Analog to Digital Converter
DAC	Digital to Analog Converter
DCI	Digitally Controlled Impedance
DDR	Double Data Rate
DSP	Digital Signal Processing
EPROM	Erasable Programmable Read-Only Memory
FBGA	Fineline Ball Grid Array
FPDP	Front Panel Data Port
FPGA	Field Programmable Gate Array
JTAG	Joint Test Action Group
LED	Light Emitting Diode
LV TTL	Low Voltage Transistor Logic level
LVDS	Low Differential Data Signaling
LSB	Least Significant Bit(s)
LVDS	Low Voltage Differential Signaling
MGT	Multi-Gigabit Transceiver
MSB	Most Significant Bit(s)
PCB	Printed Circuit Board
PCI	Peripheral Component Interconnect
PCI-e	PCI Express
PLL	Phase Locked Loop
PMC	PCI Mezzanine Card
QDR	Quadruple Data rate
SDRAM	Synchronous Dynamic Random Access memory
SRAM	Synchronous Random Access memory

Table 1: Glossary

1.2 Related Documents

- IEEE Std 1386.1-2001: IEEE Standard Physical and Environmental Layers for PCI Mezzanine Cards (PMC).
- ANSI/VITA 20-2001 : Conduction Cooled PMC.
- ANSI/VITA 42.0-2005: XMC Switched Mezzanine Card Auxiliary Standard.
- ANSI/VITA 42.3-2006: XMC PCI Express Protocol Layer Standard
- IEEE Std 1386-2001: IEEE Standard for a Common Mezzanine Card (CMC) Family.
- [Xilinx Virtex-5 Documentation](#)
- [Xilinx Virtex-6 Documentation](#)

1.3 General description

The FM680 is a high performance XMC, optionally conduction cooled, dedicated to digital signal processing applications with high bandwidth and complex algorithms requirements. It offers various interfaces, fast on-board memory resources, one Virtex-5 FPGA with embedded PCI-express endpoint or Serial Rapid IO and one Virtex-6 device. It can be utilized, for example, to accelerate frequency-domain algorithms with off-the-shelf Intellectual Property cores for applications that require the highest level of performances. The FM680 is mechanically and electrically compliant to the standard and specifications listed in section 1.2 of this document. A top level diagram is depicted in Figure 1.

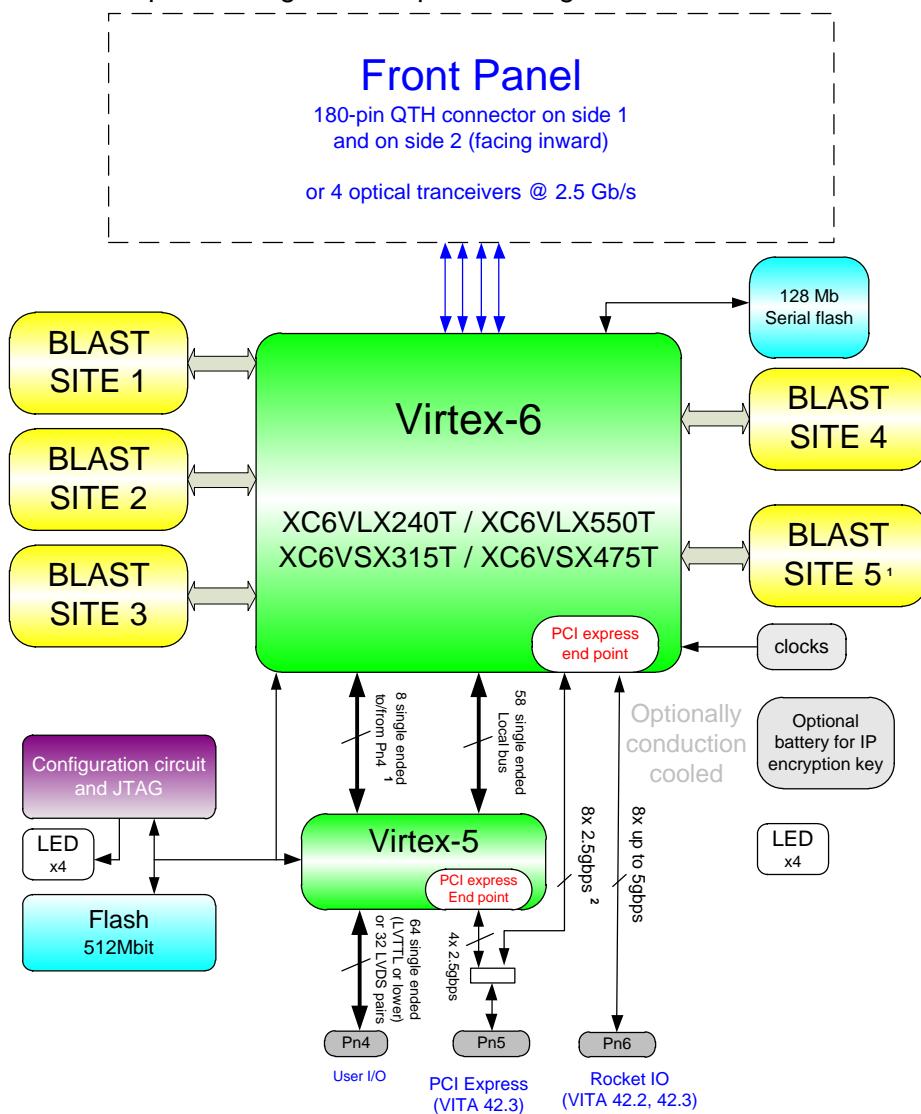


Figure 1: FM680 block diagram

Build on the success of its predecessor boards of the FM48x series the FM680 also uses the BLAST technology. A total of 5 BLAST sites connect directly to the Virtex-6 FPGA.

BLAST, Board Level Advanced Scalable Technology, is a small PCB module that allows customization of the FM680 in memory extensions, processing units and communication interfaces. For more information about the available BLASTs on the FM680 please consult the following page: BLAST modules <http://www.4dsp.com/BLAST.htm>

2 Installation

2.1 Requirements and handling instructions

- The FM680 must be installed on a motherboard compliant to the VITA 42.3 standard.
- Do not flex the board
- Observe ESD precautions when handling the board to prevent electrostatic discharges.
- Do not install the FM680 while the motherboard is powered up.

2.2 Firmware and software

Drivers, API libraries and a program example working in combination with a pre-programmed firmware for both FPGAs are provided. The FM680 is delivered with an interface to the Xilinx PCI-e endpoint core in the Virtex-5 device as well as an example VHDL design in the Virtex-6 device so users can start performing high bandwidth data transfers over the PCI bus right out of the box. For more information about software installation and FPGA firmware, please refer the 4FM Get Started Guide.

3 Design

3.1 FPGA devices

The Virtex-5 and Virtex-6 FPGA devices interface to the various resources on the FM680 as shown on Figure 1. They also interconnect to each other via 58 general purpose pins including 4 clock pins (2 pairs, one in each direction, 100Ω terminated). A 16 bits single ended bus is also available between the two FPGA devices for communication with the Pn4 bus or general purpose communication.

3.1.1 Virtex-5 device family and package

The Virtex-5 device is from the Virtex-5 LX family. It can be either an XC5VLX20T or XC5VLX30T in a Fineline Ball Grid array with 323 balls (FF323).

3.1.2 Virtex-6 device family and package

The Virtex-6 device is dedicated to Digital Signal Processing, video processing or communication applications and can be chosen from the SXT or LXT family devices. Its package is based on Fineline Ball Grid array with 1759 balls. In terms of logic and dedicated DSP resources, the FPGA B can be chosen from the following types: LX240T, LX550T, SX315T and the SX475T (FF1759).

3.2 Inter-FPGA interface

The Virtex-5 device is connected to the Virtex-6 device using a 54 pin bus plus 2 differential clock signals. Also there are 16 single ended pins available that can be used as general

purpose IO or as a connection to the Pn4 bus. Please be aware that 8 of those extra bits are available only on the SX475T and the LX550T FPGA types.

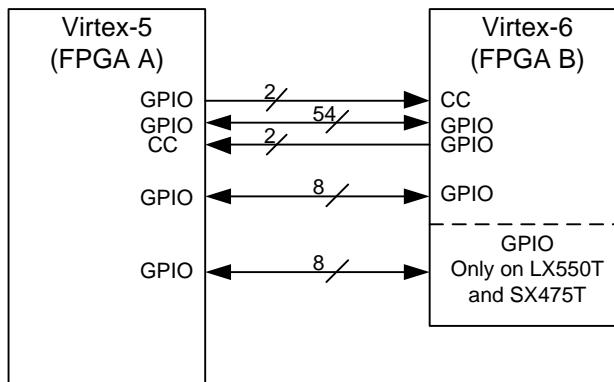


Figure 2: Inter-FPGA Interface

By default 4DSP delivers a reference design that uses the interfpga bus to allow high speed data transfer and command distribution between the PCIe interface in the FPGA A and the FPGA B.

The standard reference design does not implement the PN4 connection since those connections will depend on the user specific application. The user is free to modify the reference design and add specific features in FPGA A and FPGA B.

The connections between the FPGA A and FPGA B are described in the following table.

Table 2: interFPGA connections

net name	FPGA A bank	FPGA A IO voltage	FPGA A ball	FPGA B bank	FPGA B IO voltage	FPGA B ball
INTER_FPGA0	1	BLAST0_VIO	A7	34	BLAST0_VIO	AU13
INTER_FPGA1	1	BLAST0_VIO	A6	34	BLAST0_VIO	AR13
INTER_FPGA2	1	BLAST0_VIO	E9	34	BLAST0_VIO	AP13
INTER_FPGA3	1	BLAST0_VIO	D8	34	BLAST0_VIO	AN13
INTER_FPGA4	1	BLAST0_VIO	D10	34	BLAST0_VIO	AM13
INTER_FPGA5	1	BLAST0_VIO	D9	33	BLAST0_VIO	AK14
INTER_FPGA6	1	BLAST0_VIO	C8	33	BLAST0_VIO	AL14
INTER_FPGA7	1	BLAST0_VIO	C7	33	BLAST0_VIO	AM14
INTER_FPGA8	1	BLAST0_VIO	B9	34	BLAST0_VIO	AN14
INTER_FPGA9	1	BLAST0_VIO	F8	34	BLAST0_VIO	AR14
INTER_FPGA10	1	BLAST0_VIO	B6	34	BLAST0_VIO	AT14
INTER_FPGA11	1	BLAST0_VIO	C6	34	BLAST0_VIO	AV14
INTER_FPGA12	1	BLAST0_VIO	A8	34	BLAST0_VIO	BA14
INTER_FPGA13	1	BLAST0_VIO	F7	34	BLAST0_VIO	BB14
INTER_FPGA14	1	BLAST0_VIO	A9	34	BLAST0_VIO	BA15
INTER_FPGA15	1	BLAST0_VIO	D7	34	BLAST0_VIO	AY15
INTER_FPGA16	1	BLAST0_VIO	E7	34	BLAST0_VIO	AW15
INTER_FPGA17	1	BLAST0_VIO	B10	34	BLAST0_VIO	AV15
INTER_FPGA18	1	BLAST0_VIO	C10	34	BLAST0_VIO	AR15
INTER_FPGA19	11	BLAST0_VIO	D13	34	BLAST0_VIO	AP15

INTER_FPGA20	11	BLASTO_VIO	D14	33	BLASTO_VIO	AN15
INTER_FPGA21	11	BLASTO_VIO	E15	33	BLASTO_VIO	AL15
INTER_FPGA22	11	BLASTO_VIO	D15	33	BLASTO_VIO	AK15
INTER_FPGA23	11	BLASTO_VIO	E14	33	BLASTO_VIO	AJ15
INTER_FPGA24	11	BLASTO_VIO	F14	33	BLASTO_VIO	AJ16
INTER_FPGA25	11	BLASTO_VIO	A11	33	BLASTO_VIO	AM16
INTER_FPGA26	11	BLASTO_VIO	A12	33	BLASTO_VIO	AN16
INTER_FPGA27	11	BLASTO_VIO	C12	33	BLASTO_VIO	AT16
INTER_FPGA28	11	BLASTO_VIO	D18	34	BLASTO_VIO	AV16
INTER_FPGA29	11	BLASTO_VIO	B13	34	BLASTO_VIO	AW16
INTER_FPGA30	11	BLASTO_VIO	A13	34	BLASTO_VIO	BA16
INTER_FPGA31	11	BLASTO_VIO	G14	34	BLASTO_VIO	BB16
INTER_FPGA32	11	BLASTO_VIO	G15	34	BLASTO_VIO	BB17
INTER_FPGA33	11	BLASTO_VIO	B14	34	BLASTO_VIO	AY17
INTER_FPGA34	11	BLASTO_VIO	A14	34	BLASTO_VIO	AW17
INTER_FPGA35	11	BLASTO_VIO	G13	33	BLASTO_VIO	AU17
INTER_FPGA36	11	BLASTO_VIO	F13	33	BLASTO_VIO	AT17
INTER_FPGA37	11	BLASTO_VIO	C15	33	BLASTO_VIO	AR17
INTER_FPGA38	11	BLASTO_VIO	B15	33	BLASTO_VIO	AM17
INTER_FPGA39	11	BLASTO_VIO	B16	33	BLASTO_VIO	AL17
INTER_FPGA40	11	BLASTO_VIO	A16	33	BLASTO_VIO	AK17
INTER_FPGA41	11	BLASTO_VIO	F16	33	BLASTO_VIO	AJ17
INTER_FPGA42	11	BLASTO_VIO	G16	33	BLASTO_VIO	AJ18
INTER_FPGA43	11	BLASTO_VIO	A18	33	BLASTO_VIO	AK18
INTER_FPGA44	11	BLASTO_VIO	A17	33	BLASTO_VIO	AN18
INTER_FPGA45	11	BLASTO_VIO	E17	33	BLASTO_VIO	AP18
INTER_FPGA46	11	BLASTO_VIO	E16	33	BLASTO_VIO	AR18
INTER_FPGA47	11	BLASTO_VIO	C17	33	BLASTO_VIO	AU18
INTER_FPGA48	11	BLASTO_VIO	F17	33	BLASTO_VIO	AV18
INTER_FPGA49	11	BLASTO_VIO	D12	33	BLASTO_VIO	AW18
INTER_FPGA50	11	BLASTO_VIO	E12	33	BLASTO_VIO	AY18
INTER_FPGA51	11	BLASTO_VIO	C18	33	BLASTO_VIO	BB18
INTER_FPGA52	11	BLASTO_VIO	B18	33	BLASTO_VIO	BB19
INTER_FPGA53	11	BLASTO_VIO	F18	33	BLASTO_VIO	BA19
INTER_FPGA_IO0	13	PN4_V	H13	34	BLASTO_VIO	AM12
INTER_FPGA_IO1	13	PN4_V	H15	34	BLASTO_VIO	AR12
INTER_FPGA_IO2	13	PN4_V	H16	34	BLASTO_VIO	AT12
INTER_FPGA_IO3	13	PN4_V	L14	34	BLASTO_VIO	AU12
INTER_FPGA_IO4	13	PN4_V	K15	34	BLASTO_VIO	AW12
INTER_FPGA_IO5	13	PN4_V	L13	34	BLASTO_VIO	BB13
INTER_FPGA_IO6	13	PN4_V	J14	34	BLASTO_VIO	AW13
INTER_FPGA_IO7	13	PN4_V	J15	34	BLASTO_VIO	AV13

INTER_FPGA_IO8	13	PN4_V	H18	21	BLASTO_VIO	AW27
INTER_FPGA_IO9	13	PN4_V	J18	21	BLASTO_VIO	AW26
INTER_FPGA_IO10	13	PN4_V	J17	21	BLASTO_VIO	AW25
INTER_FPGA_IO11	13	PN4_V	K17	21	BLASTO_VIO	AY27
INTER_FPGA_IO12	13	PN4_V	L17	21	BLASTO_VIO	BA25
INTER_FPGA_IO13	13	PN4_V	L16	21	BLASTO_VIO	BA26
INTER_FPGA_IO14	13	PN4_V	G18	21	BLASTO_VIO	BB26
INTER_FPGA_IO15	13	PN4_V	H17	21	BLASTO_VIO	BB27
INTER_FPGA_CLK_A_to_Bn	4	2V5	V7	34	BLASTO_VIO	AY13
INTER_FPGA_CLK_A_to_Bp	4	2V5	V8	34	BLASTO_VIO	AY14
INTER_FPGA_CLK_B_to_An	4	2V5	P9	34	BLASTO_VIO	AP12
INTER_FPGA_CLK_B_to_Ap	4	2V5	R9	34	BLASTO_VIO	AP11

3.3 PCI-express architecture

The Virtex-5 device is connected to the XMC connector (P15) and offers a PCI Express® Endpoint block integrated in the FPGA. The endpoint will support a 4 lanes generation 1 PCI-express bus.

A PCI express switch is used to optionally route the 4 lanes from the P15 connector to the Virtex-6 device instead of the Virtex-5 device. The remaining 4 transceiver lanes on the P15 connector are routed to the Virtex-6 device as well. This makes it possible to have an 8 lanes generation 1 PCI-express bus connecting to the Virtex-6 device. If this option is selected the 4 lanes connection towards the Virtex-5 device is not available.

The standard reference design has the PCI Express connection towards the Virtex-5 FPGA. 4DSP can provide a reference design for the 8-lanes connection to the Virtex-6 FPGA. Please consult with your sales contact for more details.

The following performances have been recorded with the FM680 transferring data on the bus using the standard 4DSP PCIe interface design:

- **PCIe 1 lane: 150Mbytes/s sustained**
- **PCIe 4 lanes: 600Mbytes/s sustained**
- **PCIe 8 lanes: 800Mbytes/s sustained**

Higher performance transfers are possible but will require modifications to the PCIe interface design. Please consult with your sales contact for more details.

Furthermore the VITA 42.3 standard defines an optional P16 connector which can carry an additional 8 lanes of high speed signaling. All these lanes are routed to the Virtex-6 device directly. An overview of the PCI-express subsystem is shown in Figure 3.

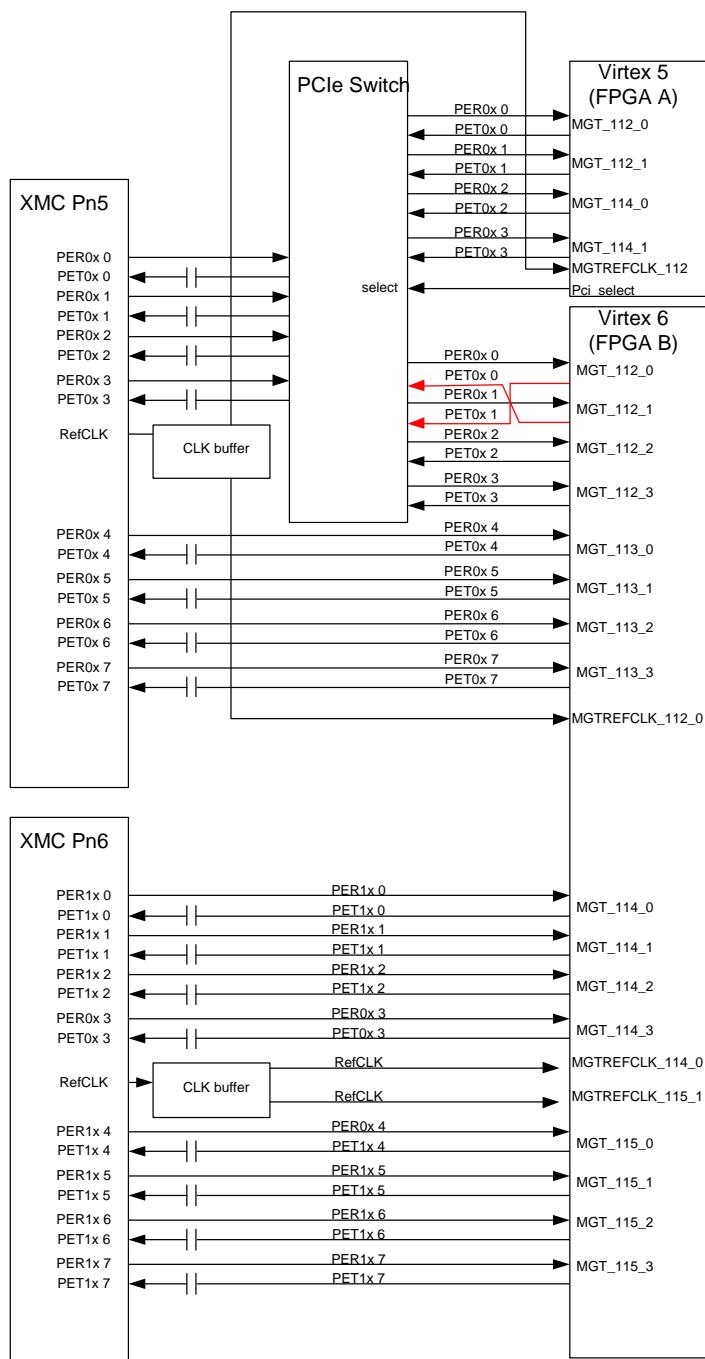


Figure 3: PCI-express subsystem diagram.

NOTE:

There is a swap between the PET0TX0 and PET0TX1 on the FM680.

3.4 XMC P15 connector

The Table 3 shows the pin out as defined by VITA 42.3. Only the highlighted pins are connected on the FM680. Table 4 indicates the signals usage and on board connections.

Table 3: XMC P15 pin out as per VITA 42.3

	A	B	C	D	E	F
1	PET0p0	PET0n0	3.3V	PET0p1	PET0n1	VPWR
2	GND	GND	TRST#	GND	GND	MRSTI#
3	PET0p2	PET0n2	3.3V	PET0p3	PET0n3	VPWR
4	GND	GND	TCK	GND	GND	MRSTO#
5	PET0p4	PET0n4	3.3V	PET0p5	PET0n5	VPWR
6	GND	GND	TMS	GND	GND	+12V
7	PET0p6	PET0n6	3.3V	PET0p7	PET0n7	VPWR
8	GND	GND	TDI	GND	GND	-12V
9	RFU	RFU	RFU	RFU	RFU	VPWR
10	GND	GND	TDO	GND	GND	GA0
11	PER0p0	PER0n0	MBIST#	PER0p1	PER0n1	VPWR
12	GND	GND	GA1	GND	GND	MPRESENT#
13	PER0p2	PER0n2	3.3VAUX	PER0p3	PER0n3	VPWR
14	GND	GND	GA2	GND	GND	MSDA
15	PER0p4	PER0n4	RFU	PER0p5	PER0n5	VPWR
16	GND	GND	MVMRO	GND	GND	MSCL
17	PER0p6	PER0n6	RFU	PER0p7	PER0n7	RFU
18	GND	GND	RFU	GND	GND	RFU
19	REFCLK+0	REFCLK-0	RFU	WAKE#	ROOT0#	RFU

Table 4: XMC P15 connections

FPGA Pin	Name/Description	FPGA Bank	DIR	XMC P15	
				Pin Number	Pin Name
V5_U8	PCIexpress reset input	4	I	F2	MRSTI#
n.a.	Connected to GND	n.a.	O	F12	MPRESENT#
n.a.	Not connected	n.a.	O	C11	MBIST#
n.a.	Conencted to TDO	n.a.	I	C8	TDI
n.a.	Conencted to TDI	n.a.	O	C10	TDO
n.a.	VPOWER is used to generate local 5V	n.a.	I	...	VPWR
n.a.	General ground for FM680	n.a.	I	...	GND
n.a.	Connects to -12V of daughter card.	n.a.	I	F8	-12V
n.a.	Connects to +12V of daughter card. and is used for on board voltage control circuits	n.a.	I	F6	+12V
n.a.	Used directly	n.a.	I	...	3.3V
Refer to Figure 3	Connects to Virtex-5 and Virtex-6	n.a.	O	...	PET0p/n[7..0]
Refer to Figure 3	Connects to Virtex-5 and Virtex-6	n.a.	I	...	PER0p/n[7..0]

3.5 XMC P16 connector

The Table 5 shows the pin out as defined by VITA 42.3. Only the highlighted pins are connected on the FM680. Table 6 indicates the signals usage and on board connections.

Table 5: XMC P15 pin out as per VITA 42.3

	A	B	C	D	E	F
1	PET1p0	PET1n0	UD	PET1p1	PET1n1	UD
2	GND	GND	UD	GND	GND	UD
3	PET1p2	PET1n2	UD	PET1p3	PET1n3	UD
4	GND	GND	UD	GND	GND	UD
5	PET1p4	PET1n4	UD	PET1p5	PET1n5	UD
6	GND	GND	UD	GND	GND	UD
7	PET1p6	PET1n6	UD	PET1p7	PET1n7	UD
8	GND	GND	UD	GND	GND	UD
9	RFU	RFU	UD	RFU	RFU	UD
10	GND	GND	UD	GND	GND	UD
11	PER1p0	PER1n0	UD	PER1p1	PER1n1	UD
12	GND	GND	UD	GND	GND	UD
13	PER1p2	PER1n2	UD	PER1p3	PER1n3	UD
14	GND	GND	UD	GND	GND	UD
15	PER1p4	PER1n4	UD	PER1p5	PER1n5	UD
16	GND	GND	UD	GND	GND	UD
17	PER1p6	PER1n6	UD	PER1p7	PER1n7	UD
18	GND	GND	UD	GND	GND	UD
19	REFCLK+1	REFCLK-1	UD	RFU	ROOT1#	UD

Table 6: XMC P16 connections

FPGA Pin	Name/Description	FPGA Bank	DIR	XMC P15	
				Pin Number	Pin Name
Refer to Figure 3	Connects to Virtex-6	n.a.	O	...	PET1p/n[7..0]
Refer to Figure 3	Connects to Virtex-6	n.a.	I	...	PER1p/n[7..0]

3.6 Pn4 user I/O connector

The Pn4 connector is connected to the Virtex-5 device.

Connector pin	Signal name	FPGA pin		FPGA pin	Signal name	Connector pin
1	Pn4_IO0	R1		T1	Pn4_IO1	2
3	Pn4_IO2	V1		U1	Pn4_IO3	4
5	Pn4_IO4	P2		P3	Pn4_IO5	6
7	Pn4_IO6	V2		V3	Pn4_IO7	8
9	Pn4_IO8	R2		T2	Pn4_IO9	10
11	Pn4_IO10	U4		U3	Pn4_IO11	12
13	Pn4_IO12	K12		L18	Pn4_IO13	14
15	Pn4_IO14	M11		K16	Pn4_IO15	16
17	Pn4_IO16	M14		M13	Pn4_IO17	18
19	Pn4_IO18	M16		M15	Pn4_IO19	20
21	Pn4_IO20	M10		N11	Pn4_IO21	22
23	Pn4_IO22	T17		T16	Pn4_IO23	24
25	Pn4_IO24	T12		R12	Pn4_IO25	26
27	Pn4_IO26	T18		U18	Pn4_IO27	28
29	Pn4_IO28	P10		N10	Pn4_IO29	30
31	Pn4_IO30	U16		U15	Pn4_IO31	32
33	Pn4_IO32	V18		V17	Pn4_IO33	34
35	Pn4_IO34	R10		R11	Pn4_IO35	36
37	Pn4_IO36	V16		V15	Pn4_IO37	38
39	Pn4_IO38	T11		U11	Pn4_IO39	40
41	Pn4_IO40	R14		T14	Pn4_IO41	42
43	Pn4_IO42	V10		U10	Pn4_IO43	44
45	Pn4_IO44	U14		T13	Pn4_IO45	46
47	Pn4_IO46	P12		P13	Pn4_IO47	48
49	Pn4_IO48	U13		V13	Pn4_IO49	50
51	Pn4_IO50	V12		V11	Pn4_IO51	52
53	Pn4_IO52	R17		R16	Pn4_IO53	54
55	Pn4_IO54	R15		P18	Pn4_IO55	56
57	Pn4_IO56	K14		P15	Pn4_IO57	58
59	Pn4_IO58	N18		N17	Pn4_IO59	60
61	Pn4_IO60	N16		N15	Pn4_IO61	62
63	Pn4_IO62	N13		N12	Pn4_IO63	64

Table 7 : Pn4 pin assignment

3.7 Serial FLASH

A 128 Mbits serial flash device (S25FL128P) is available to the Virtex-6 device. This flash allows the storage of vital data like processor boot code and settings into a non volatile memory.

The flash is operated using a standard SPI interface that can run up to 104 MHz, allowing for a page programming speed up to 208 KB/s. Reading data from the flash can be done at speeds up to 13 MB/s.

The SPI programming pins is connected to a bank that supports 1V8, whereas the serial flash is operating at 3V3. This will not cause problems for the signals from the Virtex-6 to the flash device but the signal from the flash device to the Virtex-6 are passed through a level translator (SN74AVC4T245).

3.8 BLAST sites

Thanks to the availability of 5 BLAST sites a wide variety of memory and processing modules can be connected to the Virtex-6 device. For each BLAST site it is possible to choose from the list of available BLAST modules.

For more information about the available BLASTs on the FM680 please consult the following page: BLAST modules <http://www.4dsp.com/BLAST.htm>

Table 8: BLAST Configuration Options

BLAST SITE	1	2	3	4	5 ⁽³⁾
Single BLAST	YES	YES	YES	YES	YES
Single Extended BLAST ⁽¹⁾	YES	YES	YES	YES	YES
Double BLAST ⁽²⁾	YES	YES		YES	YES
Double Extended BLAST ⁽¹⁾⁽²⁾	YES	YES		YES	YES

- 1) Single and double extended BLAST placed in BLAST sites 4 and 5 will protrude 3mm from edge of the board.
- 2) BLAST SITES 1 and 2, 4 and 5 are paired when using double BLAST.
- 3) Only available on XC6VLX550T and SX475T FPGA devices

Table 9: BLAST Memory/Processing Options

BLAST SITE	1	2	3	4	5 ⁽¹⁾
DDR3	YES	YES	YES	YES	NO
DDR2	YES	YES	YES	YES	NO
QDR	YES	YES	YES	YES	YES
ADV212 JPEG2000	YES	YES	YES	YES	YES
32GB NAND FLASH	YES	YES	YES	YES	YES

1) Only available on XC6VLX550T and SX475T FPGA devices

Due to its small form factor and ease of design, the BLAST modules enable a rapid solution for custom memory or processing requirements.

3.9 External IO interfaces

The Virtex-6 device interfaces to the front panel daughter card on the FM680 via a high speed connector. 174 I/Os are available from the FPGA to/from the daughter card that can be mounted in the IO area defined by the XMC standard. As an alternative solution it is also possible to have 4 optical transceivers in the IO area.

3.9.1 Front Panel daughter card

(Only available with front panel daughter card purchase and not in combination with the optical transceivers)

The Virtex-6 device interfaces to a 180-pin connector placed in the Front panel I/O area (on both side 1 of the PCB). It serves as a base for a daughter card and offers I/O diversity to the FM680 PMC. The FPGA I/O banks are powered either by 1.8V or 2.5V via a large 0 ohms resistor (2.5V is the default if not specified otherwise at the time of order). Using the Xilinx DCI termination options to match the signals impedance allows many electrical standards to be supported by this interface. The VRN and VRP pins on the I/O banks connected to the daughter card connector are respectively pulled up and pulled down with 50Ω resistors in order to ensure optimal performances when using the Xilinx DCI options. The VREF pins are connected to 0.9V for DDR2 DCI terminations. Please, contact 4DSP Inc. for more information about available daughter card types.

The 180-pin Samtec connector pin assignment is as follows. All signals shown as LVDS pairs in the table can also be used for any standard that does not breach the electrical rules of the Xilinx I/O pad. The FP_Xi signals in the table below are routed as single ended.

Connector pin	Signal Name	FPGA pin		FPGA pin	Signal name	Connector pin
1	FP_P0	J12		A16	FP_P1	2
3	FP_N0	J11		B16	FP_N1	4
5	FP_X0	C13		D12	FP_X1	6
7	FP_P2 ⁽²⁾	M13		J13	FP_P3	8
9	FP_N2 ⁽²⁾	N13		K13	FP_N3	10
11	FP_X2	K14		L14	FP_X3	12
13	FP_P4	H13		D16	FP_P5	14
15	FP_N4	G12		C16	FP_N5	16
17	FP_X4	H15		G14	FP_X5	18
19	FP_P6	F12		D13	FP_P7	20
21	FP_N6	E12		E13	FP_N7	22
23	FP_X6	E15		F15	FP_X7	24
25	FP_P8	B14		A15	FP_P9	26
27	FP_N8	C14		A14	FP_N9	28
29	FP_X8	C15		D15	FP_X9	30
31	FP_P10 ⁽²⁾	M14		M16	FP_P11	32
33	FP_N10 ⁽²⁾	N14		N15	FP_N11	34
35	FP_X10	H14		G13	FP_X11	36
37	FP_P12	A17		L16	FP_P13	38
39	FP_N12	B17		L15	FP_N13	40
41	FP_X12	J16		H16	FP_X13	42
43	FP_P14	D18		K17	FP_P15	44
45	FP_N14	C18		J17	FP_N15	46
47	FP_X14	M18		N18	FP_X15	48
49	FP_P16 ⁽²⁾	N16		L12	FP_P17 ⁽¹⁾	50
51	FP_N16 ⁽²⁾	P16		M12	FP_N17 ⁽¹⁾	52
53	FP_X16	K18		J18	FP_X17	54
55	FP_P18 ⁽¹⁾	E14		H18	FP_P19	56
57	FP_N18 ⁽¹⁾	F14		G18	FP_N19	58
59	FP_X18	G16		F16	FP_X19	60

Table 10 : Front Panel IO daughter card pin assignment Bank A⁽¹⁾ Connected to a global clock pin on the FPGA. LVDS output not supported.⁽²⁾ Connected to a regional clock pin on the FPGA. LVDS output not supported.

Connector pin	Signal Name	FPGA pin		FPGA pin	Signal name	Connector pin
61	FP_P20	G19		E19	FP_P21	62
63	FP_N20	F19		E18	FP_N21	64
65	FP_X20	C19		B19	FP_X21	66
67	FP_P22	F17		B18	FP_P23	68
69	FP_N22	G17		A19	FP_N23	70
71	FP_X22	J15		K15	FP_X23	72
73	FP_P24 ⁽²⁾	P18		G23	FP_P25	74
75	FP_N24 ⁽²⁾	P17		H23	FP_N25	76
77	FP_X24	D17		E17	FP_X25	78
79	FP_P26	B24		C24	FP_P27	80
81	FP_N26	A24		C23	FP_N27	82
83	FP_X26	G22		F22	FP_X27	84
85	FP_P28	B23		H21	FP_P29	86
87	FP_N28	B22		J21	FP_N29	88
89	FP_X28	F21		E22	FP_X29	90
91	FP_P30	E24		C21	FP_P31	92
93	FP_N30	E23		D21	FP_N31	94
95	FP_X30	H20		G21	FP_X31	96
97	FP_P32	K20		A22	FP_P33	98
99	FP_N32	L20		A21	FP_N33	100
101	FP_X32	D23		D22	FP_X33	102
103	FP_P34	B21		J22	FP_P35 ⁽²⁾	104
105	FP_N34	A20		K22	FP_N35 ⁽²⁾	106
107	FP_X34	J20		H19	FP_X35	108
109	FP_P36 ⁽²⁾	L22		L21	FP_N36 ⁽²⁾	110
111	3.3V/2.5V/1.8V				Vbatt ⁽³⁾	112
113	FP_X36	K19		L19	FP_X37	114
115	3.3V/2.5V/1.8V				0.9V	116
117	3.3V/2.5V/1.8V				3.3V/2.5V/1.8V	118
119	FP_X38	F32		F31	FP_X39	120

Table 11: Front Panel IO daughter card pin assignment Bank B

⁽¹⁾ Connected to a global clock pin on the FPGA. LVDS output not supported.

⁽²⁾ Connected to a regional clock pin on the FPGA. LVDS output not supported.

⁽³⁾ Vbatt is connected to both Virtex devices Vbatt pin.

Connector pin	Signal Name	FPGA pin		FPGA pin	Signal name	Connector pin
121	FP_P37	E32		C20	FP_P38	122
123	FP_N37	D32		D20	FP_N38	124
125	FP_X40	E35		D35	FP_X41	126
127	FP_P39	B33		A32	FP_P40	128
129	FP_N39	C33		B32	FP_N40	130
131	FP_X42	G33		G32	FP_X43	132
133	FP_P41	H31		A34	FP_P42	134
135	FP_N41	G31		A35	FP_N42	136
137	FP_X44	D33		E33	FP_X45	138
139	FP_P43	L29		B34	FP_P44	140
141	FP_N43	L30		C34	FP_N44	142
143	FP_X46	J32		J31	FP_X47	144
145	FP_P45 ⁽¹⁾	A36		M28	FP_P46	146
147	FP_N45 ⁽¹⁾	B36		M29	FP_N46	148
149	FP_X48	K29		K30	FP_X49	150
151	FP_P47	H30		C35	FP_P48	152
153	FP_N47	J30		C36	FP_N48	154
155	FP_X50	AH31		AG31	FP_X51	156
157	FP_P49	D36		E34	FP_P50	158
159	FP_N49	D37		F34	FP_N50	160
161	FP_X52	AH29		AG29	FP_X53	162
163	FP_P51	T30		AG32	FP_P52	164
165	FP_N51	R30		AF31	FP_N52	166
167	FP_X54	AH30		AJ30	FP_X55	168
169	FP_P53 ⁽²⁾	N33		R32	FP_P54	170
171	FP_N53 ⁽²⁾	P33		T32	FP_N54	172
173	FP_X56	V31		W31	FP_X57	174
175	FP_P55 ⁽¹⁾	AD31		AK33	FP_P56	176
177	FP_N55 ⁽¹⁾	AD30		AJ32	FP_N56	178
179	FP_X58	AJ31		AK30	FP_X59	180

Table 12 : Front Panel IO daughter card pin assignment Bank C

3.9.2 Power connection to the front panel I/O daughter card

The Front Panel I/O daughter card on side 1 of the PCB is powered via a 7-pin connector of type BKS (Samtec). Each pin can carry up to 1.5A. The power connector's pin assignment is as follows.

Pin #	Signal	Signal	Pin #
1	+3.3V	+3.3V	2
3	+5V	GND	4
5	+12V	GND	6
7	-12V		

Table 13: Daughter card power connector pin assignment on PMC side 1

3.9.3 Front Panel optical transceivers

(Special build option and not in combination with the front panel daughter card)

Four 2.5 GB/s optical transceivers (LTP-ST11M) are available on the FM680 in the front panel area. They are connected to the MGT I/Os of the Virtex-6. Infiniband protocols as well as Gigabit Ethernet and Fibre channel (sFPDP) can be implemented over the transceivers. Lower rate optical transceivers (2.125 GB/s and 1.0625 GB/s) are available in the same form factor.

The Figure 4 shows the block diagram of the optical transceivers on the FM680 and Figure 5 shows the location of the optical transceivers on the PCB. Table 14 shows the pin assignments for each serial lane and the optical transceiver it connects to.

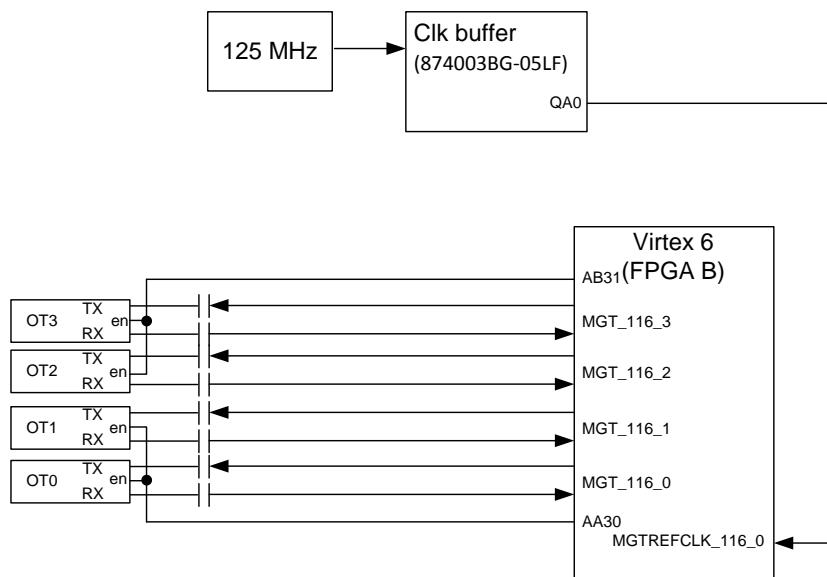


Figure 4: Optical transceiver connections

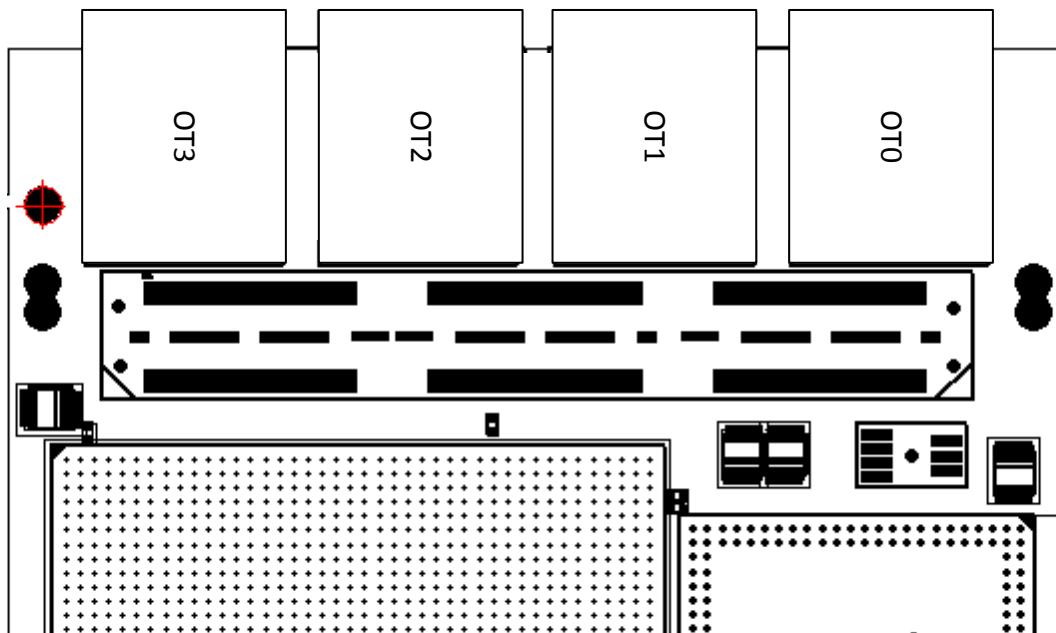


Figure 5: Optical transceiver locations

Table 14: Optical transceiver MGT connections

FPGA Pin	Net Name	MGT Block	Optical transceiver
K4	MGT_FP_RXp3	116_3	OT3
K3	MGT_FP_TXp3		
J6	MGT_FP_RXn3		
J5	MGT_FP_RXp3		
L2	MGT_FP_RXp2	116_2	OT2
L1	MGT_FP_TXp2		
L6	MGT_FP_RXn2		
L5	MGT_FP_RXp2		
M4	MGT_FP_RXp1	116_1	OT1
M3	MGT_FP_TXp1		
N6	MGT_FP_RXn1		
N5	MGT_FP_RXp1		
N2	MGT_FP_RXp0	116_0	OT0
N1	MGT_FP_TXp0		
P8	MGT_FP_RXn0		
P7	MGT_FP_RXp0		

3.9.4 Optical transceiver MGT Reference Clock

A low jitter oscillator connects to the 874003BG-05LF. Depending on the resistor configuration this device can output a 312.5, 156.25 or 125 MHz clock. The default configuration outputs a 156.25 MHz reference clock. The Figure 6 and Table 15 show the selection resistor locations and type.

Table 15: Optical transceiver reference clock frequency selection resistors

Resistor	Type	MGT REFCLK
R510	Pull up (<i>default</i>)	FSEL0
R518	Pull down	
R294	Pull up (<i>default</i>)	FSEL1
R494	Pull down	
R292	Pull up (<i>default</i>)	FSEL2
R293	Pull down	

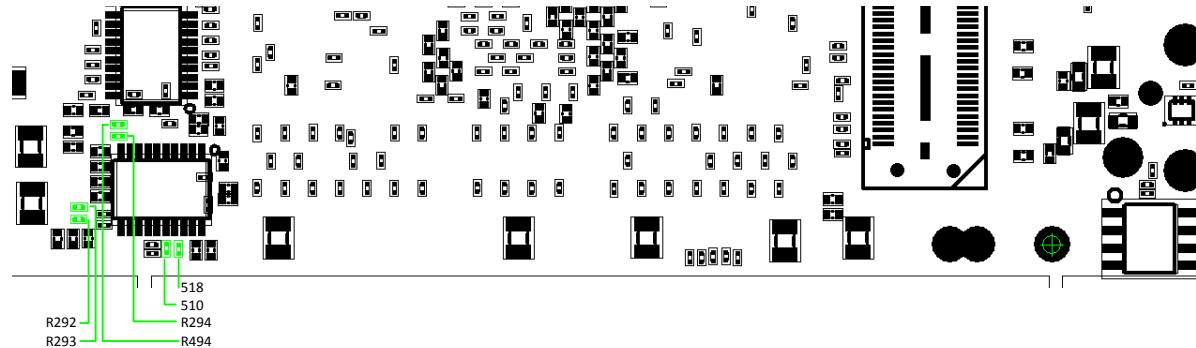


Figure 6: Optical transceiver reference clock selection resistors locations

3.10 FPGA LED

Four LEDs are connected to the Virtex-5 device. In the default FPGA firmware, the LEDs are driven by the Virtex-5 device. The following table shows the meaning of the LEDs in the standard reference design.

	OFF	ON	FLASHING
LED 0 (red)	PCIexpresslink down	PCIexpress link up	n.a.
LED 1 (red)	No PCI express traffic	PCI express traffic	PCI express traffic
LED 2 (red)	No PCI express traffic	PCI express traffic	PCI express traffic
LED 3 (red)	FM680 PCB revision 2	FM680 PCB revision 1 (only when FPGA A firmware revision is 2.3 or higher)	n.a.

Table 16: LED board status

The LEDs are located on side 2 of the PCB in the front panel area. Their locations are depicted in Figure 7.

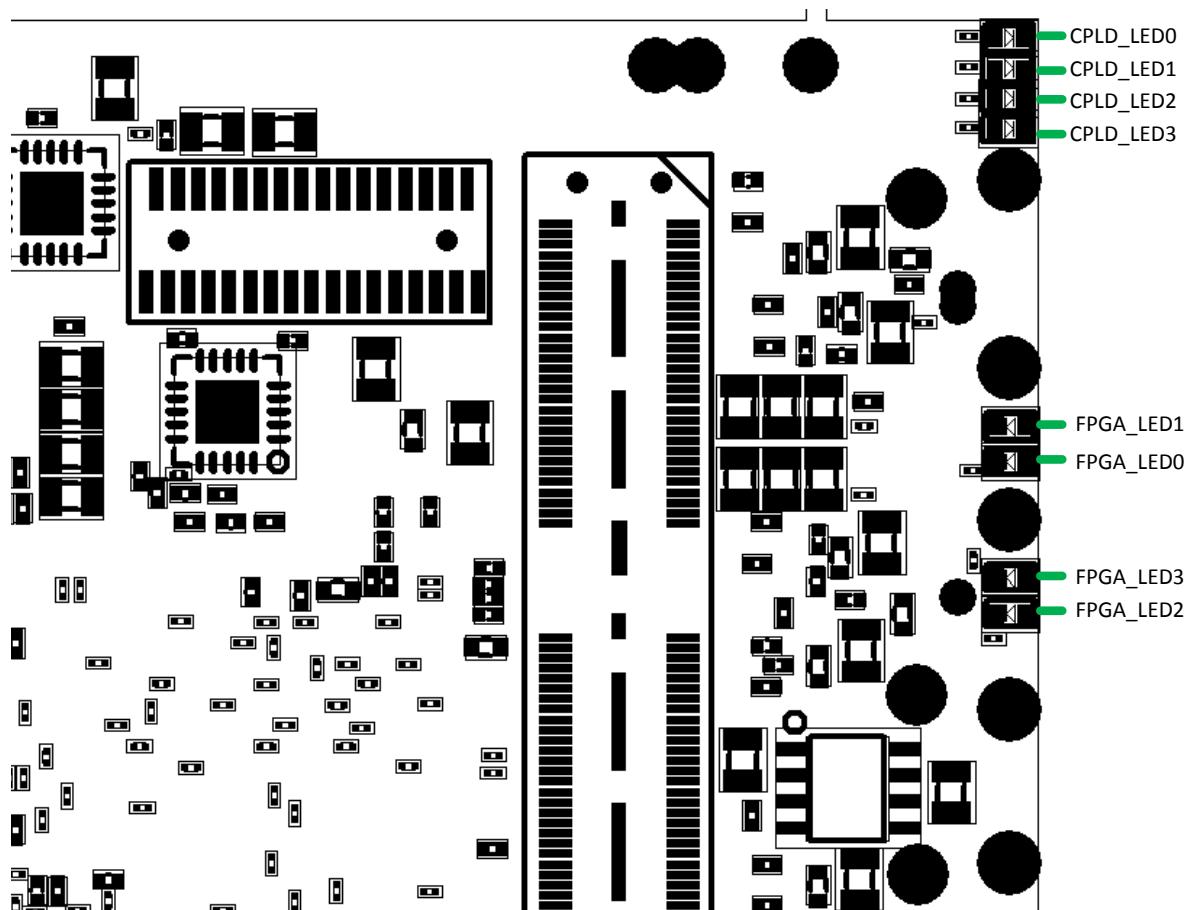


Figure 7: FPGA and CPLD LED locations

To turn on a LED drive the signal low. To turn a LED off, make the signal high.

FPGA Pin	Net Name	FPGA Bank	DIR
C13	FPGA_LED0	11	O
C16	FPGA_LED1	11	O
D17	FPGA_LED2	11	O
B11	FPGA_LED3	11	O

Table 17: FPGA LED connections

The I/O standard to be assigned depends on BLAST configuration.

3.11 FPGA configuration

3.11.1 Flash storage

The FPGA firmware is stored on board in a flash device. The 512Mbit device is partly used to store the configuration for both FPGAs. In the default CPLD firmware configuration, the Virtex-5 device and the Virtex-6 device are directly configured from flash if a valid bit stream is stored in the flash for each FPGA. The flash is pre-programmed in factory with the default firmware example for both FPGAs.

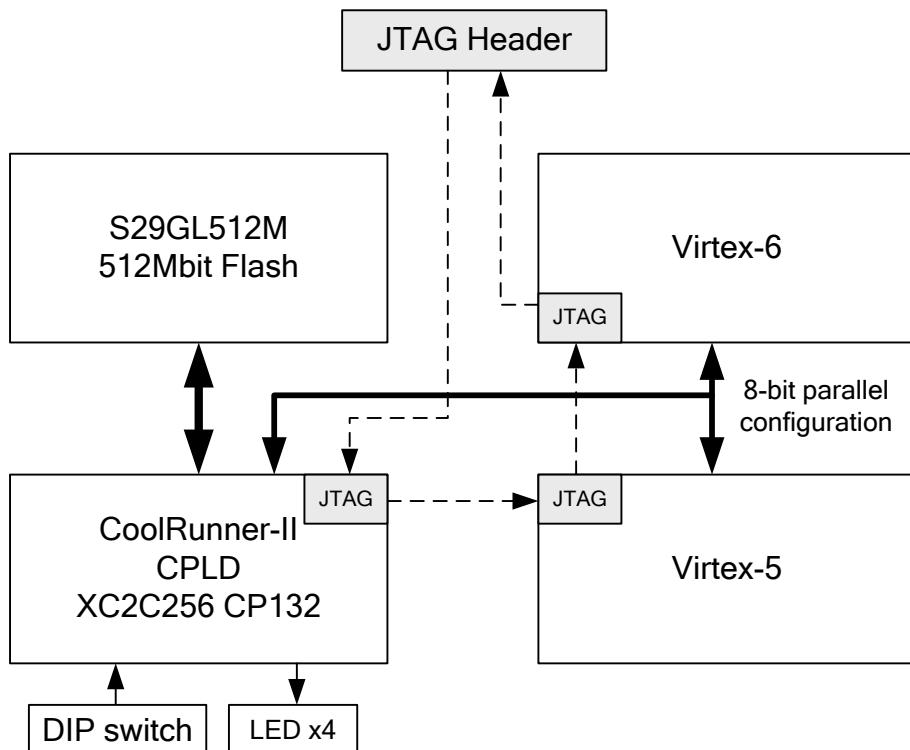


Figure 8 : Configuration circuit

3.11.2 CPLD device

As shown on Figure 7, a Cool Runner-II CPLD is present on board to interface between the flash device and the FPGA devices. The CPLD is used to program and read the flash. The data stored in the flash is transferred from the host motherboard via the PCI-express bus to the Virtex-5 device and then to the CPLD that writes the required bit stream to the storage device. A 31.25 MHz clock connects to the CPLD and is used to generate the configuration clock sent to the FPGA devices. At power up, if the CPLD detects that an FPGA configuration bit stream is stored in the flash for both FPGA devices, it will start programming the devices in SelecMap mode.

Do NOT reprogram the CPLD without 4DSP's approval

The CPLD configuration is achieved by loading with a Xilinx download cable a bit stream from a host computer via the JTAG connector. The FPGA devices configuration can also be achieved via the JTAG chain.

3.11.2.1 DIP Switch

A switch (J1) is located next to the JTAG programming connector (J6) see Figure 9. The switch positions are defined as follows:

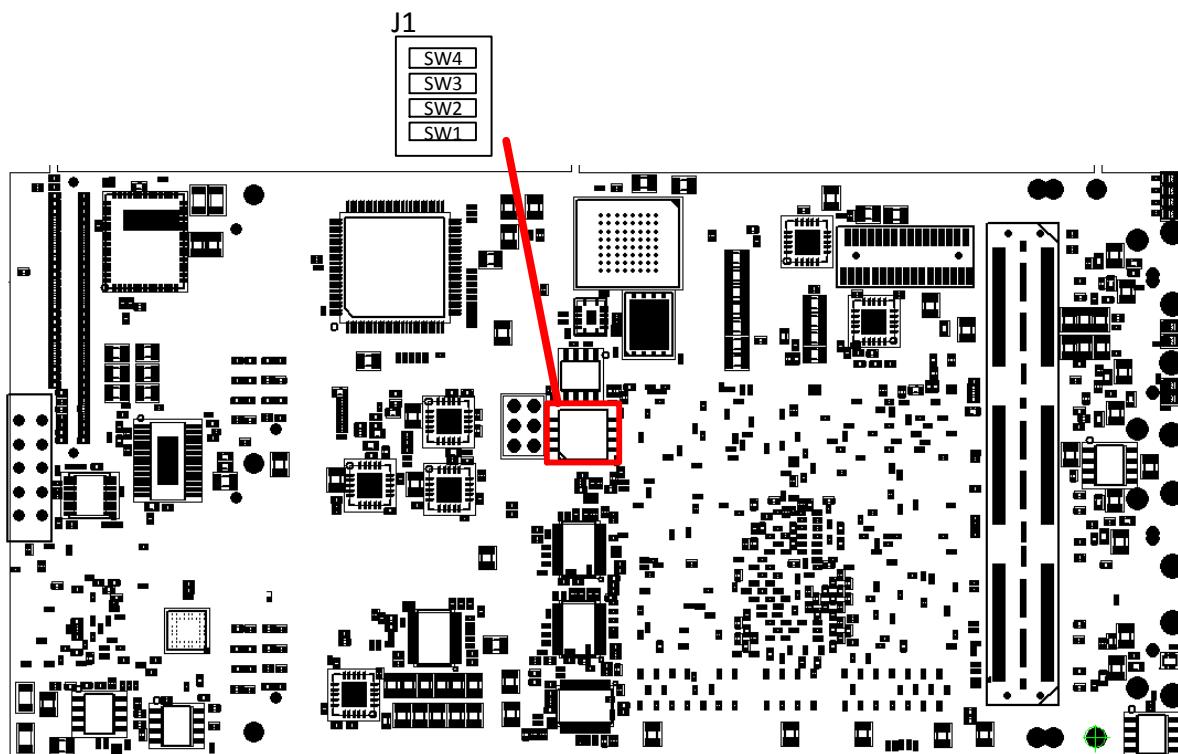


Figure 9: switch (J1) location

Sw1	OFF	Default setting. The Virtex-5 device configuration is loaded from the flash at power up.
	ON	Virtex-5 device safety configuration loaded from the flash at power up. To be used only if the Virtex-5 device cannot be configured or does not perform properly with the switch in the OFF position.
Sw2		Reserved (should be OFF)
Sw3		Reserved (should be ON)
Sw4		Reserved (should be OFF)

Table 18: Switch description

3.11.2.2 LED and board status

Four LEDs connect to the CPLD and give information about the board status.

	OFF	ON	FLASHING
LED 0 (red)	FPGA A configured	FPGA A not configured	FPGA A or B bit stream or user_ROM_register is currently being written to the flash
LED 1 (red)	FPGA B configured	FPGA B not configured	FPGA A or B bit stream or user_ROM_register is currently being written to the flash
LED 2 (red)	FLASH idle	FLASH busy	Safety configuration loaded into FPGA A, or attempted to load.
LED 3 (red)	No CRC error detected	CRC error. Presumably a wrong or corrupted FPGA bit stream has been written to the flash. Once on this LED remains on	n.a.

Table 19: LED board status

The LEDs are located on side 2 of the PCB in the front panel area. Their locations are depicted in Figure 7.

3.11.3 JTAG

A JTAG connector is available on the FM680 for configuration purposes. The JTAG can also be used to debug the FPGA design with the Xilinx Chipscope. A press fit connector is delivered with the board that can be plugged into the connector holes.

The JTAG connector can be placed on both sides of the PCB. The connector location seen from the bottom of the PCB is shown in Figure 10.

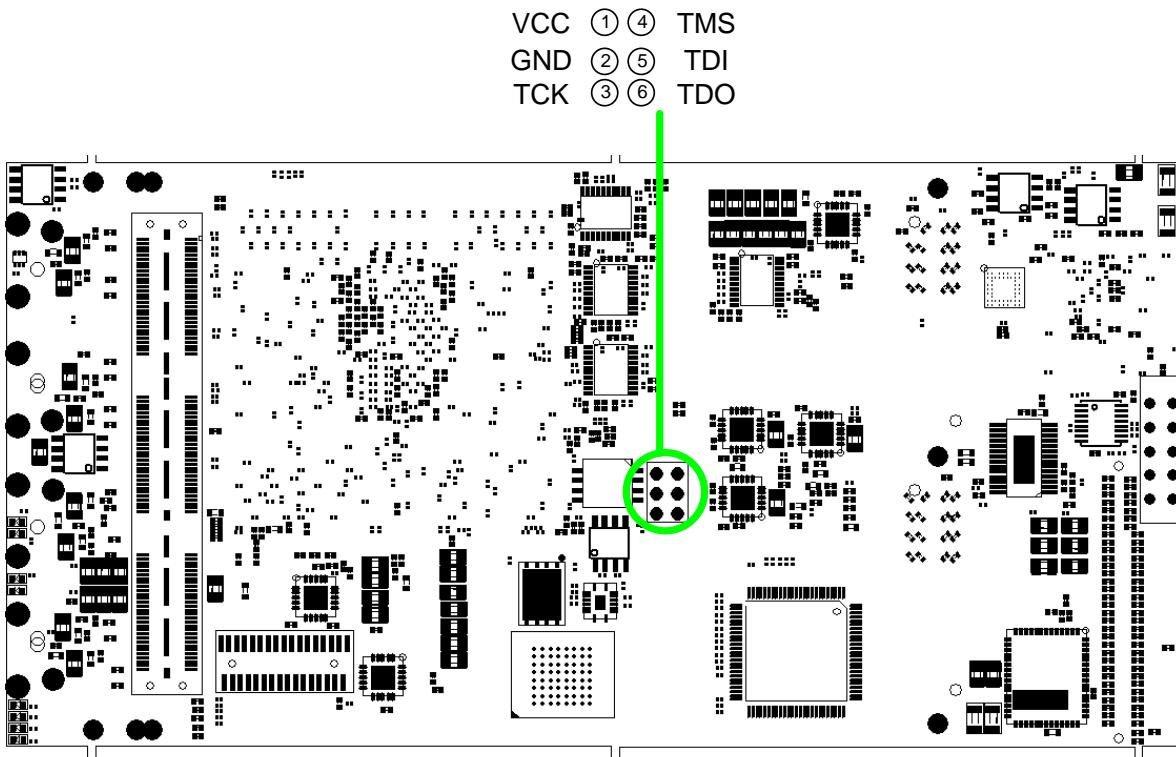


Figure 10: JTAG connector (J6) location

The JTAG connector pinout is as follows:

Pin #	Signal	Signal	Pin #
1	1.8V	TMS	4
2	GND	TDI	5
3	TCK	TDO	6

Table 20 : JTAG pin assignment

3.12 Clock tree

The FM680 clock architecture offers an efficient distribution of low jitter clocks.

Both FPGA devices receive a low jitter 125MHz clock. A low jitter programmable clock able to generate frequencies from 62.5MHz to 255.5MHz in steps of 0.5MHz is also available.

This clock management approach ensures maximum flexibility to efficiently implement multi-clock domains algorithms and use the memory devices at different frequencies. Both clock buffer devices (CDCV1804) and the frequency synthesizer (CDCE925) are controlled by the Virtex-5 device.

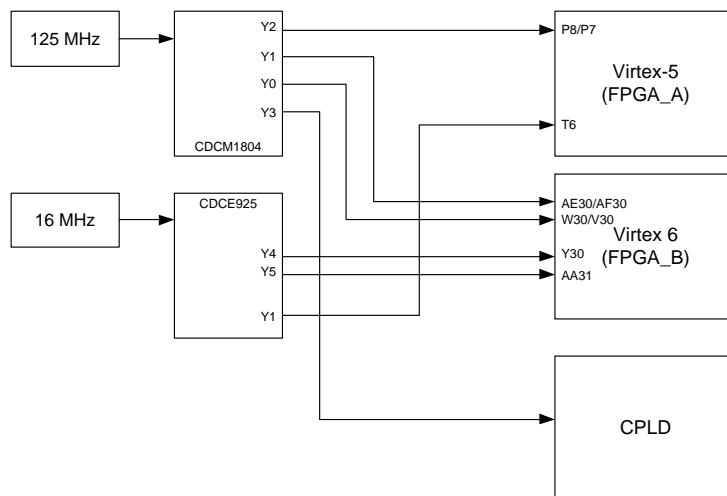


Figure 11 : Clock tree

FPGA Pin	Net Name	DIR	CDCE925, CDCV1804		
			Device	Pin Number	Pin Name
V5_T6	CLK_SYNTH_A	I	CDCE925	13	Y1
V6_Y30	CLK_SYNTH_B	I	CDCE925	7	Y4
V6_AA31	CLK_SYNTH_B	I	CDCE925	8	Y5
V5_P7	CLK125_AN	I	CDCV1804	10	Y2-
V5_P8	CLK125_AP		CDCV1804	9	Y2+
V6_V30	CLK125_B0N	I	CDCV1804	16	Y0-
V6_W30	CLK125_B0P		CDCV1804	15	Y0+
V6_AF30	CLK125_B1N	I	CDCV1804	22	Y1-
V6_AE30	CLK125_B1P		CDCV1804	21	Y1+

Table 21: Miscellaneous clock connections

4 Power requirements

The Power is supplied to the FM680 via the XMC Pn5 connector. Several DC-DC converters generate the appropriate voltage rails for the different devices and interfaces present on board.

The FM680 power consumption depends mainly on the FPGA devices work load. By using high efficiency power converters, all care has been taken to ensure that power consumption will remain as low as possible for any given algorithm.

After power up, the FM680 typically consumes 6 Watts of power. For precise power measurements it is recommended to use the Xilinx power estimation tools for both the Virtex-5 and Virtex-6 FPGA devices. The maximum current rating given in the table below is the maximum current that can be drawn from each voltage rail in the case resources are used to their maximum level.

Special precautions need to be taken to support the XMC VPOWER input, since the XMC standard dictates that this power supply can either be 12V or 5V. To overcome this, a voltage detection circuit detects whether VPOWER is 12V or 5V and enables a switching regulator or

a Field Effect Transistor (FET). If VPOWER is 12V the switching regulator converts down to 5V otherwise the FET allows 5V to pass through.

Device/Interface	Voltage	Maximum current rating
DCI and memory reference voltage	0.9V	6 A
Virtex-6 device core	1.0V	10 A
Virtex-5 device core	1.0V	2 A
BLAST core and IO,Virtex-6 I/O banks	1.8V	6A
Virtex-5 device I/O bank connected to the front panel daughter card	0.9/1.0/1.8/2.5/3.3V	...A
front Panel I/O daughter card	5V	1A
Front Panel IO daughter card	3V3	3A
Front Panel IO daughter card	12V	1A
Front Panel IO daughter card	-12V	1A
MGT power supply	1.0V, 1.2V, 2.5V	2.0A, 2.5A, 0.01A respectively

Table 22 : Power supply

Optionally, the FM680 can be used as a standalone module and is powered via the external power connector.

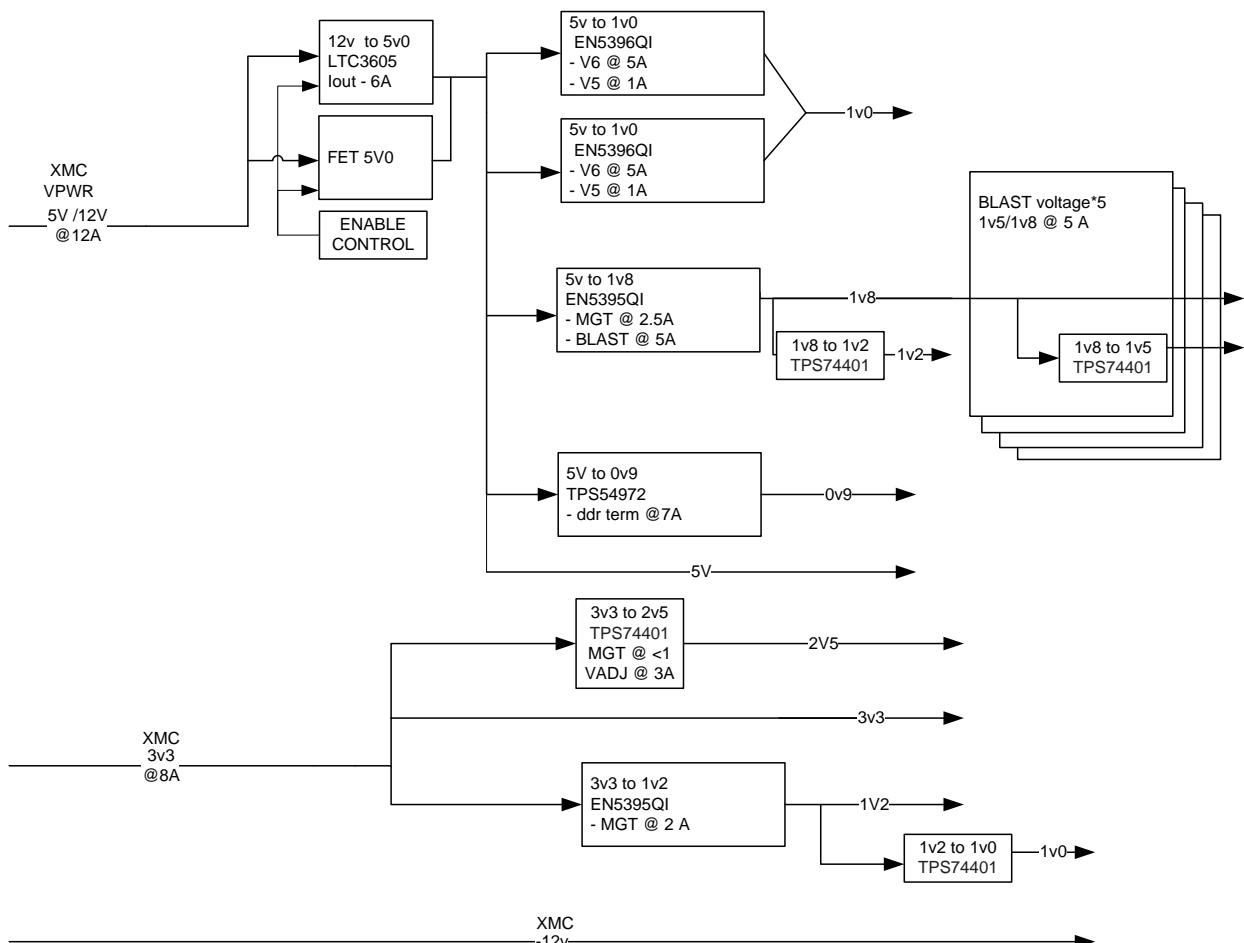


Figure 12 : Power supply

An ADT7411 device is used to monitor the power on the different voltage rails as well as the temperature. The ADT7411 data are constantly passed to the Virtex-6 device. Measurements can be accessed from the host computer via the PCI bus. A software utility delivered with the board allows the monitoring of the voltage on the 2.5V, 1.8V, 1.2V, 1.0V and 0.9V rails. It also displays both FPGAs junction temperature.

4.1 External power connector for stand alone mode

An external power connector (J2) is available on side 2 of the PMC, next to the PMC connectors. It is used to power the board when it is in stand alone mode. This is a right angled connector and it is mounted on board only if the card is ordered as a stand alone version (FM680-SA). The height and placement of this connector on the PCB breaches the PMC specifications and the module should not be used in an enclosed chassis compliant to PMC specifications if the external power connector is present on board.

Do not connect an external power source to J2 if the board is powered via the XMC connectors. Doing so will result in damaging the board.

The external power connector is of type Molex 43045-1021. Each circuit can carry a maximum current of 5A. The connector pin assignment is as follows:

Pin #	Signal	Signal	Pin #
1	3.3V	3.3V	2
3	5V	5V	4
5	GND	GND	6
7	GND	GND	8
9	-12V	12V	10

Table 23 : External power connector pin assignment

WARNING:

UNREGULATED UNPROTECTED EXTERNAL POWER SUPPLY CONNECTION

This board is designed with an UNSUPPORTED feature for an external power connector labeled as J2. Mounting a connector on the PCB breaches the PMC electrical and mechanical specifications of the PMC standard. This is a FACTORY ONLY feature that is used in the manufacturing process when powering the board is required in an UN-MOUNTED PCI bus mode, thus in stand alone mode. **DO NOT connect an external power source to J2, doing so may result in damaging the board and will automatically VOID WARRANTY.** Consult factory for further information.

5 Environment

5.1 Temperature

Operating temperature

- 0°C to +60°C (Commercial)
- -40°C to +85°C (Industrial)

Storage temperature:

- -40°C to +120°C

5.2 Convection cooling

600LFM minimum

5.3 Conduction cooling

The FM680 can optionally be delivered as conduction cooled PMC. The FM680 is compliant to ANSI/VITA 20-2001 standard for conduction cooled PMC.

6 Safety

This module presents no hazard to the user.

7 EMC

This module is designed to operate from within an enclosed host system, which is build to provide EMC shielding. Operation within the EU EMC guidelines is not guaranteed unless it is installed within an adequate host system. This module is protected from damage by fast voltage transients originating from outside the host system which may be introduced through the system.

8 Technical support

Technical support for all 4DSP Product, hardware, software and firmware is available under 4DSP Terms and Conditions of Sales ONLY in its original condition AS-SHIPPED unless agreed to by 4DSP and documented in writing, prior to any modifications.

Terms and Conditions are available from <http://www.4dsp.com/TCs.txt>

Technical support requests should be sent to support@4dsp.com

Any electrical connections made to the board or other components shall be made only with approved connectors as specifically identified in the products official documentation.

Any modification to hardware including but not limited to removing of components, soldering or other material changes to in part or in whole to the PCM and/or its components will immediately invalidate and make void any warranty or extended support if any.

Further, and changes or modifications to software and/or firmware supplied with the Product, unless provided for in the Products official documentation, shall immediately invalidate and make void any warranty or extended support if any.

9 Warranty

	<i>Hardware</i>	<i>Software/Firmware</i>
Basic Warranty (included)	1 Year from Date of Shipment	90 Days from Date of Shipment
Extended Warranty (optional)	2 Years from Date of Shipment	1 Year from Date of Shipment